IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

#17 Appeal Brief D. EVANS 9.6.03

In re Application of:
Son K. Quan et al.
Serial No.: 09/928,737
Filed: August 13, 2001
For: SEMICONDUCTOR PACKAGE AND METHOD THEREFOR

August 20, 2003

Art Unit: 2831
Examiner: Hung V. Ngo
Docket No.: SC09785T-CD1

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APPELLANTS' BRIEF ON APPEAL

COMMISSIONER OF PATENTS AND TRADEMARKS
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BOARD OF PATENT APPEALS & INTERFERENCES:

This brief is filed pursuant to 37 C.F.R. §1.192 in the matter of the Appeal to the Board of Appeals and Interferences of the rejection of the claims of the above-referenced application for patent. Authorization to charge Appellants' deposit account for fees associated with filing this Appeal Brief is provided in an accompanying Fee Transmittal paper.

REAL PARTY IN INTEREST

The present application is wholly assigned to MOTOROLA, INC., a Delaware corporation with its headquarters in Schaumburg, Illinois.

RELATED APPEALS AND INTERFERENCES

Appellants are unaware of other appeals or interferences that will directly affect, be directly affected by, or have a bearing on the Board's decision in this appeal.

STATUS OF CLAIMS

Claims 17-22 are the subject of this appeal. Claims 17-22 as presently recited were presented to the USPTO for the first time on August 13, 2001, the filing date of the present application. [Note: The present application is a continuation of a divisional application (09/062,986), divided from an original patent application (08/708,296) which issued as US Patent 5,776,798.] In a first Office Action, the Examiner issued a restriction requirement between device claims 14-16 and method claims 17-22. Appellants responded by electing method claims 17-22, with traverse. In a second Office Action, the Examiner rejected claims 17-21 under 35 USC 102 (b) as being anticipated by Tuttle et al. (US Patent 5,612,513) and rejected claim 22 under 35 USC 103(a) as being unpatentable over the same reference and made the restriction requirement final. Appellants responded to the rejection without amendment. The Examiner finally rejected the claims on the same grounds as originally rejected. Appellants then filed an RCE application to have art that was cited in a foreign counterpart application considered and made of record. No amendments were made to the claims. The Examiner issued a first Office Action final rejection of the claims on the same ground (i.e. using the Tuttle reference). Appellants did not file a Response After Final Action pursuant to 37 C.F.R. §1.116. Instead, Appellants submitted a Notice of Appeal. This Appeal Brief is submitted in support of the Notice of Appeal.

STATUS OF AMENDMENTS

No amendments have been made, nor are requested to be made, to the appealed claims. The claims are as originally presented on August 13, 2001.

SUMMARY OF THE INVENTION

Appellants' invention relates generally to semiconductor devices, and more specifically to a semiconductor package. To alleviate problems associated with non-planar packaging surfaces (which make it difficult to use automated pick and place machines to transport the devices and pose problems for marking the packages with product identifiers and logos) while also increasing manufacturing productivity and throughput, the present invention encapsulates semiconductor devices in an array format using an overmolding technique. The individual devices are then singulated using a sawing operation.

FIG. 1 shows an interconnect substrate 11 that has a plurality of substantially identical package sites 13, 14, 16, etc. arranged in an array (a four by four array is shown). Each site is separated by a space (e.g. space 17) so that each site may later be singulated along this space into an individual package. One or more semiconductor devices or elements (e.g. a component 26 shown in FIG. 2) is mounted or attached to each package site. A single and continuous encapsulant 19 (also in FIG. 2) is formed over the devices, sites and singulation spaces. As illustrated in FIG. 2, a glob-top, or liquid encapsulation process is shown, as evidence by the use of a dam-bar 18 formed by a first liquid encapsulant. The dam-bar is around the perimeter of the array and serves to constrain flow of the second encapsulant 19. However, the presently pending claims which are the subject of this appeal recite that the encapsulation process is performed by "overmolding" the encapsulant, not using a liquid dispense process. The differences between these two techniques are set forth below in reference to the rejection of claim 17. After encapsulation, the individual sites are singulated by sawing along the singulation space through the substrate and the encapsulant.

By forming a single encapsulant over all devices and sawing into individual devices, substrate space is conserved and packaging density is improved compared to prior art techniques which encapsulate individual devices separately. Planarity of the packaging surface is achieved by making the encapsulant area larger than the meniscus of the encapsulation material (if using a liquid encapsulating process) or using an overmolding process. The planar surfaces allow use of automated pick and place handles (which typically rely on a vacuum action to move the packages from one location to another) and facilities better marking of the package surfaces as compared to prior art encapsulation techniques.

ISSUES

1) Are claims 17-21 anticipated by Tuttle et al. (US 5,612,513) under 35 U.S.C. 102(b)?
2) Is claim 22 unpatentable over Tuttle et al. (US 5,612,513) under 35 U.S.C. 103(a)?

GROUPING OF CLAIMS

Group A → Claims 17 and 20
Group B → Claim 18
Group C → Claim 19
Group D → Claim 21
Group E → Claim 22

The requested division is on the basis that the claims of Groups B, C, D and E each recite additional limitations distinct from those in Group A and one another and also not found in the Tuttle reference.

ARGUMENTS

Arguments Regarding 102(b) Rejection→ Group A

Claim 17 is rejected by the Examiner under 35 USC 102(b) as being anticipated by Tuttle et al. (US 5,612,513). Appellants respectfully disagree with this rejection because Tuttle et al. fails to disclose each and every element of claim 17 (which is the base independent claims from which all other rejected claims depend) as is required for a proper rejection under 35 USC 102(b).

More specifically, Tuttle fails to disclose at least the recited step of "*overmolding a single and continuous encapsulant*" (see line 8 of claim 17 in the following Appendix of appealed claims). Appellants respectfully submit that encapsulant 60 of FIG. 4 of Tuttle is not formed by an overmolding process as the Examiner contends. An overmolding process is one in which a mold on one side of a substrate is used to define the final encapsulant shape and profile. Tuttle, in contrast, teaches using a liquid encapsulant dispense process wherein the shape of the encapsulant is defined by dam 54 which constrains the flow of the encapsulant only around a perimeter until it is hardened through a cure. See column 6, lines 31-44 of Tuttle. This is true not only of encapsulant 60 taught by Tuttle but also of the encapsulants in the other embodiments of Tuttle, including encapsulant 30, encapsulant 90, encapsulant 118, and encapsulant 142. In short, Appellants' respectfully submit that Tuttle teaches a liquid dispense encapsulation process, as opposed to an overmolded encapsulation process as claimed by Appellants.

For the Board's reference, Appellants are herein providing an excerpt (pp. 599-603) from the book "*Fundamentals of Microsystems Packaging,*" by Rao R. Rummala which is intended to help the Board understand generally the differences between a transfer molding process (of which overmolding is a type) and a liquid dispense or "glob top" process. Additionally, Appellants are herein submitting a copy of US Patent 5,280,193 that explains more precisely that "*over*molding" is a molding process in

which just one side of the substrate is encapsulated by a molding process (see column 3, lines 30-34). A publication entitled "Overmold Technology Applied to Caivty Down Ultrafine Pitch PBGA Pacakge" by Ouimet et al. appearing in the proceedings of the 1998 Electronic Components and Technology Conference on pages 458-462 also supports this definition. It thus should be apparent that liquid encapsulation and transfer molding techniques are not the same, and thus the rejection under 35 USC 102(b) is not proper because Tuttle. fails to disclose an overmolding process.

Appellants provided the above-mentioned references to the Examiner for consideration in support of Appellants' arguments but in the Final Rejection of the claims the Examiner said Appellants' arguments were not persuasive. The Examiner upholds the rejection even in view of Appellants' arguments firstly because Appellants' specification recites that a "dam-bar 18 could be a premanufactured frame applied to area 12 and overmolding or other techniques could be used for the encapsulating" (citing page 6, lines 6-9 of the specification). Secondly, the Examiner states that Tuttle discloses a dam 54 which is equivalent to a mold or frame on one side of the substrate.

Regarding the Examiner's first point, the fact that Appellants' specification makes reference to use of a dam bar in one embodiment but says that overmolding could instead be an alternative embodiment does not mean that the two techniques are the same or even equivalent. Furthermore, it is clear that claim 17 specifically recites "overmolding" rather than the liquid dispense technique.

Regarding the Examiner's second point, Appellants respectfully disagree that dam 54 of Tuttle is equivalent to an overmolding processing. The excerpt (pp. 599-603) from the book "*Fundamentals of Microsystems Packaging,*" by Rao R. Rummala herein provided clearly supports Appellants' position on this point, identifying "two major categories" of encapsulation processes (molding and liquid encapsulation) and going into detail to describe and differentiate the two. One of ordinary skill in the art clearly differentiates a molded encapsulation process from a liquid encapsulation process, and thus one skilled in the art would look at Tuttle as only disclosing a liquid encapsulation process and not a molding encapsulation process, be it overmolding (on one side of a substrate) or two-sided molding.

For at least the above reasons, Appellants respectfully submit that rejection of claim 17 under 35 USC 102(b) as being anticipated by Tuttle is in error and therefore respectfully request the Board to reverse the Examiner's rejection.

Regarding claim 20 of this Group A, Appellants submit that Tuttle teaches singulating the individual circuits of an array after encapsulation. But as with claim 17, Appellants' submit Tuttle fails to teach "overmolding", instead teaching a liquid encapsulation dispense process. The rejection of claim 20 will therefore likely be deemed proper or improper depending upon the Boards conclusion with respect to claim 17, which is why Appellants have grouped claims 17 and 20 together.

Arguments Regarding 102(b) Rejection→ Group B

Claim 18 of Group B recites that the top surface of the encapsulant has a surface deviation of less than 0.13 millimeters across a length of the encapsulant. The Examiner rejects this claim under 35 USC 102(b) as being anticipated by Tuttle.

Appellants submit this rejection is in error for at least all of the reasons set forth above in regard to the rejection of claim 17 (from which claim 18 depends). But additionally, Appellants submit that Tuttle fails to disclose or suggest any specific dimensions or dimensional relationship regarding the top surface of encapsulant 60, other than that it has a "substantially flat top surface" (See col. 6, lines 56-57). The Examiner cannot properly rely upon the apparently perfectly flat surface shown in FIG. 4 because figures cannot be relied upon for dimensions or scale unless the specification specifically states that the figures are drawn to scale. *Hockerson-Halberstadt, Inc. v Avia Group International Inc., 35 USPQ 2d 1487 (Fed. Cir. 2000).* See also MPEP § 2125. While pictures may be relied upon if they would reasonably teach one of ordinary skill in the art, one skilled in the art of liquid encapsulation will appreciate that it is very difficult to achieve a planar surface with a liquid dispense encapsulation process, even when using a dam to constrain the flow of the encapsulant. The nature of liquid surfaces and surface tensions leads to formation of a dome shape without use of a dam, and formation of a meniscus (i.e. a concavity) when using a dam. (See, for example, FIG. 15.4 on page 602 of the Rummala excerpt provided herein.) Without a frame or mold being used to define the top surface (which Tuttle does not disclose), and without proper

sizing of the array in the case of using a liquid encapsulant (which Tuttle also does not disclose) Appellants submit that the Examiner cannot rely upon any figure in Tuttle as teaching or disclosing the recited planarity of the top surface of the encapsulation across the length of the encapsulant.

The Examiner responded to the Appellants' above agruments by stating that "substantially flat top surface" as recited in Tuttle means one with "zero surface deviation". Appellants submit the Examiner's definition of "zero surface deviation" is simply not supported by Tuttle, and that one skilled in the art recognizes that "zero surface deviation" could not be achieved using a liquid dispense process without aide of a mold, frame or cavity to define the surface by confining the liquid, or without proper sizing of the array as taught by Appellants.

The rejection of claim 18 is therefore believed to be in error and Appellants respectfully request the Board to reverse the Examiner's rejection.

Arguments Regarding 102(b) Rejection→ Group C

Claim 19 of Group C recites that the plurality of package sites are arranged in an array of at least four by four. The Examiner also rejects this claim under 35 USC 102(b) as being anticipated by Tuttle.

The Examiner refers to FIG. 4 of Tuttle in support of this rejection , apparently alleging that this figure discloses an array of at least four by four package sites. Again, Appellants respectfully disagree. Appellants submit this rejection is in error for at least all of the reasons set forth above in regard to the rejection of claim 17 (from which claim 18 depends). But additionally, Appellants submit that Tuttle does not disclose a four by four array. Tuttle's FIG. 4 is a cross-sectional view of FIG.3. As is very apparent from FIG. 3, circuit array 40 is a three by four array, which is not "at least four by four" as recited in claim 19. Therefore Tuttle again fails to disclose all recited claim elements and limitations and the rejection under 35 USC 102(b) is improper.

Moreover, the size of the array is an important factor in determining the planarity of the top surface of the package, particularly in regard to liquid dispense encapsulants, as Appellants' point out beginning on page 5, line 25. Appellants teach that the larger the array, the better able one is to achieve a planar surface (e.g. because the meniscus has less of effect the larger the array). Tuttle fails to recognize this aspect.

The Examiner failed to address Appellants' arguments regarding claim 19 in the Final Rejection but none the less maintained the rejection. For at least the above reasons, Appellants' submit the anticipation rejection of claim 19 is in error and respectfully requests the Board to reverse the Examiner.

Arguments Regarding 102(b) Rejection→ Group D

Claim 21 of Group D recites that singulation of the package sites comprises "sawing through the single and continuous encapsulant and the interconnect substrate along the singulation space." The Examiner rejects this claim under 35 USC 102(b) as being anticipated by Tuttle. The Examiner relies upon Tuttle's statement at col. 5, lines 46-50, which states that "the array can be singulated to separate the individual circuits" and that the singulation process can be "by routing or shearing or any other method known in the art".

Appellants submit this rejection is in error for at least all of the reasons set forth above in regard to the rejection of claims 17 and 20 (from which claim 21 depends). But additionally, because sawing is not the same as "routing" or "shearing" and because the Examiner has failed to show that sawing through a molded encapsulation material for singulation purposes is another "known method." Accordingly, Appellants respectfully request the Board to reverse the Examiner's rejection of claim 21.

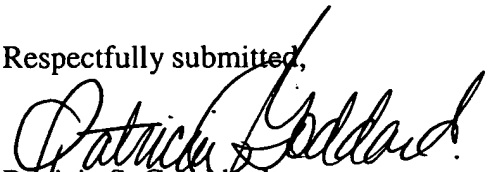
Arguments Regarding 103(a) Rejection→ Group E

Claim 22 (Group E) recites that the method further comprises the step of handling each singulated device with automated pick and place equipment. The Examiner rejected dependent claim 22 under 35 USC 103(a) as being obvious in view of Tuttle, contending that while Tuttle does not disclose the step of handling each device with automated pick and place equipment, that use of automated handling equipment in the electrical art is well know.

Appellants submit this rejection is in error for at least all of the reasons set forth above in regard to the rejection of claims 17 and 20 (from which claim 22 depends). But additionally, for at least the following reasons. While automated handling equipment itself is well known, Appellants submit that devices formed by glob top or a liquid dispense encapsulation processes (which is what is taught by Tuttle) are known to result in non-planar top surface, and therefore cause problems with automated handling tools which often rely upon vacuum pick-up heads. The non-planar surface makes it difficult to hold or pull a vacuum on the surface. Appellants point out this problem in the Background section of the present application (see page 1, lines 14-24). Accordingly, Appellant's submit it would not be obvious to use automated handling equipment for the device of Tuttle because the encapsulation process of these type of devices (a liquid dispense process) generally produces an insufficiently planar pick-up surface unless made of a particular size (as Appellants' teach) or using a mold or frame to define the planar surface. Tuttle fails to disclose or suggest this aspect of the liquid encapsulation process. Therefore one skilled in the are would not be motivated to use automated pick and place equipment on Tuttle's devices. And while one skilled in the art might be motivated to use an automated process generally to increase throughput (a widespread goal of manufacturing operations), the ability to do so with the devices of Tuttle would be lacking for the reasons set forth above.

Accordingly, Appellants respectfully submit that the rejection of claim 22 under 35 USC 103(a) is in error and request the Board to reverse the Examiner's rejection of this claim.

Respectfully submitted,



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APPENDIX

17. A method for making a packaged semiconductor device comprising:
providing an interconnect substrate having a plurality of substantially identical package sites arranged in an array, the plurality of sites being separated by a singulation space;
mounting and interconnecting a semiconductor device within each site; and
overmolding a single and continuous encapsulant over each semiconductor device, the plurality of sites, and the singulation space.

18. The method of claim 17 wherein overmolding produces a top surface of the encapsulant which has a surface deviation of less than 0.13 millimeters across a length of the encapsulant.

19. The method of claim 17 wherein providing an interconnect substrate comprises providing an interconnect substrate wherein the plurality of package sites are arranged in an array of at least four by four package sites.

20. The method of claim 17 further comprising the step of singulating the plurality of package sites after overmolding.

21. The method of claim 20 wherein singulating comprises sawing through the single and continuous encapsulant and the interconnect substrate along the singulation space.

22. The method of claim 21 wherein singulating produces a plurality of packaged semiconductor devices, and further comprising the step of handling each packaged semiconductor device with automated pick and place equipment.